



3.4 FIELD TESTING

3.5 TRAINING

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(Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy, Air Force, and NASA projects.

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Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES in sufficient detail to show full compliance with the specification:

#### SD-01 Preconstruction Submittals

- ISO 9001 Registration
- Radio Systems

#### SD-02 Shop Drawings

- Record Drawings

#### SD-03 Product Data

- Radio Transmitter Specifications
- Radio Receiver Specifications
- Radio Power and Miscellaneous Specifications
- Radio Voice Frequency Specifications
- Radio Physical Specifications
- Radio System Diagnostics
- Status and Alarm Information
- Diagnostic and Control Functions
- Remote Radio Display
- Radio Accessibility
- Omni-directional Antenna for Master Station
- TRANSMISSION CABLE AND MISCELLLLANEOUS ITEMS FOR MASTER STATION
- Directional Antenna for Remote System
- Transmission Cable & Miscellaneous Items for Remote Station

#### SD-08 Manufacturer's Instructions

- Spare Parts List
- Test Equipment
- Radio System Performance
- Training sessions for both Engineering and Technical personnel is required

#### SD-09 Manufacturer's Field Reports

- Field testing consists of Preliminary test and Final Acceptance tests.

## PART 2 PRODUCTS

### 2.1 GENERAL PRODUCT DESCRIPTION

The manufacturer of all radios supplied under this contract must be certified as an ISO 9001 approved facility. A certificate of [ISO 9001 registration](#) must be included with the bid documents.

All radio hardware must be capable of both analog (4-wire audio) or digital operation. Changing from analog to digital or back is achieved by software changes only.

Data throughout must be a minimum of 9600 baud within a 12.5 kHz channel. This speed is constant over the air. Radio port speeds are independently configurable from 110 to 38400 baud.

The proposed system must provide features that allow the master station radio to access all pertinent data on the operation of the remote radios without interfering with the telemetry data flow.

Software tools must be available to allow the Radio System Maintenance and Diagnostic data to be accessed from the Master radio and displayed in graphical form on a standard PC using Windows 95, Windows NT, Windows 2000, or Windows XP.

Hardware and/or software facilities that allow the Radio System Maintenance and Diagnostic data to be accessed via a web server over a network must be included in the system pricing. This feature of the radio system must allow data to be viewed from anywhere in the Enterprise.

User adjustments to radio equipment must be software-settable. Electro-mechanical adjustments are not acceptable, exclusive of helical filter adjustments for frequency changes in excess of 5 MHz.

The manufacturer must supply references (name, company, telephone number) of ten [radio systems](#) that have been operating at 9600 bps for a minimum of one year.

The vendor is responsible for system layout as required to provide a complete and operating system.

### 2.2 MASTER AND REMOTE STATION RADIO

The radio must operate in the 130-174 MHz frequency band using any fixed frequency Tx/Rx split. The radio must be able to operate in half-duplex or simplex mode. Each group of remote station radios and their associated master station radio must operate on unique transmit/receive frequency pairs, on a non-interfering basis with other master/remote systems.

The radio must be synthesized and programmable to all frequencies in the applicable frequency bands.

The radio must operate in the half-duplex mode with transmitter keying provided by the associated Remote Terminal Unit.

The radio must have, as an option, an external orderwire adapter module to accept a telephone handset. The orderwire handset must be used for voice communication to the master station for service functions.

The radio must provide a "Sleep Mode" capability. This feature enables a command from the RTU to switch the radio between a low power consumption mode and normal operation. When in "Sleep Mode", the current draw must not exceed 16 mA.

The radio must operate without outputting false data due to a squelch tail.

The remote radio must be fully synthesized. Opening the radio to change, frequency crystals, or DIP switches is unacceptable.

Antenna connectors must be Type N. Lower quality "UHF" type connectors are not acceptable.

The remote radio must have the ability to monitor its internal operation and diagnostic parameters via a hand held terminal or personal computer plugged into the remote radio. The terminal or PC must be able to monitor the following functions (functions identified by an "\*" must be user-adjustable by connecting a terminal or PC to the radio; electro-mechanical adjustments for these functions are not acceptable):

#### RADIO PARAMETERS

- \*Transmit and receive frequencies
- \*Time-out timer setting
- \*Soft carrier dekey setting
- \*PTT delay
- \*CTS delay
- \*Unit address
- Software rev level
- Serial no./model no.

#### RADIO DIAGNOSTICS

- \*Transmit power
- \*Frequency
- Regulator voltage
- Power supply voltage
- Internal temperature
- Received signal strength

Remote transceivers must contain a built-in RTU simulator to enable over-the-air tests of data polling quality. It must be possible to activate the simulator locally using radio configuration software, or remotely using the diagnostic software (see Section 2.3 "RADIO SYSTEM DIAGNOSTICS").

Remote transceivers must include a Remote RTU Reset pin on the data interface port. It must be possible to activate this pin locally using radio configuration software, or remotely using the diagnostic software (see Section 4.0). The required output for this pin must be +10 Vdc or -10 Vdc (selectable). It must be capable of supplying a current of 20 mA.

The radio must be FM/UL approved for Class I , Division 2, Groups A, B, C, D hazardous locations as an option.

The Remote Station Radio must be an MDS 1710A Transceiver manufactured by Microwave Data Systems, or approved equal. The remote station must be fully compatible with an MDS 1790 master station, or approved equal unit that provides for front panel configuration and diagnostics via an LCD screen.

### 2.2.1 Radio Transmitter Specifications

- A. Output Power (at the antenna port):  
0.1 to 5 Watts Programmable
- B. Automatic Closed Loop Power Control:  
Transmit power must be maintained at its preset output (+/- 2 dB)  
for input power variations from 10.5 to 16 VDC.
- C. Data Turn Around Time (Tx-Rx-Tx):  
10 msec including RTS/CTS time Delay.
- D. Duty Cycle:  
100%, continuous
- E. Transmit Frequency Range:  
130-174 MHz
- F. Frequency Stability:  
 $\pm 0.00015\%$ , 1.5 ppm, -30° to 60°C
- G. Modulation Type:  
Multi-level CPFSK
- H. Intermodulation:  
40 dB
- I. Output Impedance:  
50 Ohms
- J. Time-Out Timer:  
Programmable from 1 to 255 seconds, or off in 1 second  
increments; via PC or Hand-held terminal.
- K. RTS-CTS Delay:  
Programmable from 0-255 msec in 1 msec increments; via PC or  
Hand-held terminal.
- L. PTT Delay:  
Programmable from 0-255 msec in 1 msec increments, via PC or  
Hand-held terminal.
- M. Soft Carrier Dekey:  
Programmable from 0-255 msec in 1 msec increments

### 2.2.2 Radio Receiver Specifications

- A. Type:  
Dual conversion, superheterodyne
- B. Frequency Stability:  
 $\pm 0.00015\%$ , 1.5 ppm, -30° to 60°C
- C. Sensitivity/Bit Error Rate (at antenna input port):  
4 Wire Audio: -115 dBm (0.3 uV) 12 dB SINAD  
9600 bps Digital Interface: -111 dBm for 1 x 10<sup>-6</sup> BER
- E. Receive Frequency Range:  
130-174 MHz (Available Bands: 130-140 MHz, 140-150 MHz, 150-165

MHz, and 165-174 MHz.

- F. Bandwidth Compatibility:  
Programmable in 12.5 kHz increments
- G. RF Input Impedance:  
50 Ohms
- H. Intermodulation (EIA):  
-75 dB, minimum)
- I. Received Signal Strength Indicator:  
Built-in, Range: -120 dBm to -50 dBm

#### 2.2.3 Radio Power and Miscellaneous Specifications

- A. Input Power:  
Voltage: 13.8 Vdc Nominal, (10.5-16 Vdc Operating Range).
- B. Current Draw  
Transmit, 2.0 amps typical at 5 watts RF output  
Receive, 125 mA operational, Sleep Mode, 16 mA
- C. LED Indicators: Visible: PWR, DCD, TXD, RXD (not used in analog mode)  
Analog Radios - Keyline Active, Transmitter ON, Squelch Open, Power / Alarm, General Alarm.  
Digital Radios - Carrier Detect, Transmit Data, Receive Data, Power / Alarm.

#### 2.2.4 Radio Voice Frequency Specifications for Operation with an External Modem

- A. Frequency Response:  
+1, -4 dB, 50 to 3000 Hz
- B. Analog Input:  
Adjustable level from -20 to +6 dBm
- C. Output:  
Adjustable level from -20 to +6 dBm
- D. Interface:  
4-wire, 600 Ohms impedance, unbalanced
- E. Transient Protection:  
2500 Volt Isolation on VF inputs and outputs; power supply, keying, and alarm circuits (option)
- F. Data Rate:  
Radio port speeds are configurable from 110 to 38400 baud.
- G. Pre-emphasis/De-emphasis:  
The radio must contain pre-emphasis/de-emphasis circuitry, for compatibility with existing voice frequency radio equipment

#### 2.2.5 Radio Physical Specifications

- A. Mounting:



All radio PC boards including RF, modem and diagnostic PC boards must be enclosed in a single cast aluminum housing to eliminate interference with data/computer equipment. A plastic housing or a housing with vents which can allow dust into the radio is not acceptable.

B. Temperature Range:

Full performance from -30° to 60°C. Operational performance from -40° to +70°C.

C. Humidity Range:

0 to 95% relative humidity, at 40° C non-condensing

## 2.3 RADIO SYSTEM DIAGNOSTICS

The radio must include system diagnostic capability to permit automatic monitoring of key operating parameters and alarm conditions. In addition, critical radio status and alarm conditions must be annunciated on LED indicators on the front panel of the radio.

Diagnostic software must operate under MS Windows 95, Windows 2000, or Windows XP to enable an IBM compatible personal computer (PC) to communicate with the radio diagnostics controller via a separate RS-232 diagnostic port on the master station radio. The PC with software must serve as a central diagnostic reporting tool for the entire point-to-multipoint radio system. Give preferential consideration to solutions that provide for network connectivity.

The diagnostic package must support communications of diagnostic data from all remote radios in the system to the master station radio over the radio's RF channel. If a repeater radio is utilized, diagnostics from all remote radios and from the repeater must be sent over the RF channel to the polling remote radio. It is not acceptable to require a separate external communications link between the PC and the repeater radio to obtain diagnostic data at the polling remote site.

Diagnostic software must be able to accommodate any combination of communications links to remotely located master or repeater stations. Software must automatically connect to all master stations in the radio system via dedicated modem, dial up modem, or hard wired RS-232 link. Each master station, repeater station, and polling remote must have a unique diagnostic address.

### 2.3.1 STATUS AND ALARM INFORMATION

All status and alarm information obtained from the MAS radio system must be displayed on CRT screens, and if required, printed or archived to data base files for future recall and analysis. As a minimum, diagnostic software must have the following features:

A. A Windows 95™ based Graphical User Interface (GUI)

B. Ability to poll 256 Master Stations, each with up to 512 Remote Radios

C. Single screen view of the status of all radios in the system

D. Universal tab-delimited Equipment Lists and Diagnostic Report files to permit access by spreadsheet and graphing programs

- E. The ability to make all of the retrieved diagnostic data available to other SCADA software packages or computers on the same network via Dynamic Data Exchange (DDE) and/or Open Data Base Connectivity (ODBC) using Structured Query Language (SQL)
- F. Diagnostics to all radios must be performed without disruption to the payload or user data
- G. A radio link quality indication for diagnostic messages or for a combination of payload and diagnostic messages
- H. User settable alert/alarm conditions for all measured values
- I. The ability to send an automatic e-mail message via SMTP when an alarmed radio is detected
- J. Software versions optimized for 640 x 480 displays and for 1024 x 768 displays
- K. Context sensitive help screens
- L. Multi-level password protection to prevent unauthorized changes to radio parameters, diagnostic application setup, and radio system configuration

#### 2.3.2 DIAGNOSTIC AND CONTROL FUNCTIONS

Master/Repeater Station Warm Switch-over Diagnostics must provide the following diagnostic and control functions:

- A. Monitor and display the operation and status of redundant transmitters, receivers and power supplies and automatically switch over to standby radio upon failure. All modules must be continuously monitored while on line and in standby states.
- B. Remotely switch to the alternate transmitter or receiver to permit remote trouble shooting of radio hardware and software.
- C. Remotely test the Warm standby switch-over logic and alarm reporting logic.
- D. Monitor and display power supply voltage, current and transmit power of redundant power supplies and transmitters.
- E. Monitor and display received signal strength, frequency offset and FM deviation levels of redundant master station receivers.
- F. Radio Diagnostics must include control capability to permit remote adjustment of key parameters in the remote radio from a PC connected to the master radio or Polling Remote Radio. The control parameters must include as a minimum:

- Transmit Power
- Transmit Frequency Offset
- CTS Delay
- PTT Delay
- Time-Out-Timer Setting

### 2.3.3 REMOTE RADIO DISPLAY

Radio Diagnostics retrieved from the Remote Radios must display the following data:

A. The following parameters indicated by a "\*" must be remotely adjustable from the master station. All diagnostic values must be displayed in engineering units (volts, watts, dB, etc.).

- \*Transmit Power Output
- \*Transmit Frequency
- Receive Signal Strength
- Power Supply Voltage
- Internal Voltage Regulator Voltage
- Internal Radio Temperature

B. Received Signal Strength must display over the range from -120 dBm to -60 dBm.

C. Perform system diagnostics by connecting a PC to the radio. Opening the radio, changing modules, changing DIP switches or requiring an external diagnostic interface unit is unacceptable.

### 2.3.4 RADIO ACCESSIBILITY

The radio system must offer a network interface solution that enables all radio diagnostics to be available from a LAN or WAN or accessible via the Internet.

The radio diagnostic software must be InSite™ Radio System Management Software supplied by Microwave Data Systems or approved equal.

## 2.4 OMNIDIRECTIONAL ANTENNA FOR MASTER STATION

### 2.4.1 Equipment Requirements

Must meet the following requirements:

- A. Frequency Range:  
130-174 MHz, or as required
- B. Gain:  
8.0 dBd, or as required
- C. Maximum Power Input:  
500 watts
- D. VSWR:  
Less than 1.5:1
- E. Lightning Protection:  
Direct ground protection to tower
- F. Connector Input:  
Type N female connector in the antenna base.
- G. Mounting Hardware:  
Clamps, and hardware per the antenna manufacturer to adapt to the tower

#### 2.4.2 Antenna Type

Provide Celwave PD458, Decibel DB 540K, or approved equal.

#### 2.5 TRANSMISSION CABLE AND MISCELLLENEOUS ITEMS FOR MASTER STATION

Use transmission cable connecting the Master Station Radio antenna port with the antenna, which is the low-loss foam-dielectric type.

Provide a 6-foot section of "superflexible" type transmission cable at the Master Radio antenna port. Provide standard Type N connectors for connection to a continuous piece of cable extending to the antenna.

Provide weatherproof transmission cable suitable for direct environmental exposure. Use "O" ring seals on connectors.

Include all required cable hangers, ground kits, hardware, and surge suppressors. from the Master Radio to the antenna approximately 100 feet, with antenna attached to a 40 foot concrete poll.

#### 2.6 DIRECTIONAL ANTENNA FOR REMOTE SYSTEM

##### 2.6.1 Hardware Requirements

Must meet the following requirements:

- A. Frequency range:  
130-174 MHz, or as required
- B. Gain:  
10 dBd, or as required
- C. Maximum Power Input:  
250 watts
- D. Lightning Protection:  
Direct ground protection to mast
- E. Front-to-Back Ratio:  
15 dBd, minimum
- F. Connector:  
Type N, female
- G. Mounting Hardware:  
Weatherproof clamp for direct mount to pipe mast

##### 2.6.2 Antenna Type

Provide Celwave PD688S, Decibel DB 436, or approved equal.

Provide all masts, lightning suppressors, and other apparatus required to make a complete and operable radio system.

#### 2.7 TRANSMISSION CABLE & MISCELLANEOUS ITEMS FOR REMOTE STATION RADIO

Provide cable connecting the radio antenna port with the antenna which is the low-loss foam-dielectric type, 0.5 inch in diameter. Provide Andrew

Corp. LDF4-50A or approved equal.

Provide a 3 foot section of "superflexible" transmission cable at the radio antenna port. Provide standard Type N connectors for connection to a continuous piece of cable extending to the antenna.

Provide weatherproof transmission cable, suitable for direct environmental exposure. Use "O" ring seals on connections.

Include all required cable mounting hardware and accessories such as, but not limited to cable hangers, ground kits, surge suppressors, etc.

### PART 3 EXECUTION

#### 3.1 EQUIPMENT VERIFICATION

Vendor must demonstrate [radio system performance](#) through:

A. Providing references from 10 systems operating at 9600 bps or better in 12.5 kHz channels. Include Company name, contact and phone number.

B. Vendor must demonstrate a system operating at 9600 bps or better with a bit error rate of  $10^{-6}$  at -109 dBm received signal strength.

C. Vendor must provide all required support to start-up and test the system.

#### 3.2 SPARE PARTS

Vendor must include a complete itemized [Spare Parts List](#) of radio system spare parts including pricing.

#### 3.3 TEST EQUIPMENT

Vendor must include a complete list of all test equipment, and interface equipment for maintenance and diagnostic testing.

#### 3.4 FIELD TESTING

After complete installation of the equipment and at such time as directed by the Contracting Officer, conduct test to demonstrate that the installation requirements of this specification have been met and that the sequential functions of the system comply with the requirements specified herein. Tests covered in the following paragraphs must be done in two parts:

[Preliminary](#)-This must be an "in house" test to verify all the systems and components. Perform this functional test in the presence of government inspectors and repeat until one full test can be performed without device or system malfunction.

[Final Acceptance](#)-After the successful completion of the preliminary testing, the systems must be fully tested formally and full documentation (including [Record Drawings](#)) using the previously approved recording form. Contracting Officer must witness this test and final acceptance of the system will be based upon his written approval of the test. On both preliminary and final tests, follow the approved testing procedures.

### 3.5 TRAINING

Vendor must provide training for the Radio System. Training must include but not be limited to the operation and maintenance of all equipment installed or modified in this project.

Training sessions must be as follows:

Technical: 3-four hour sessions  
Engineering: 1-four hour session

-- End of Section --